UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/912,558	07/26/2001	Ronald A. Weimer	M4065.0319/P319-A	5990

24998 7590 07/29/2003

DICKSTEIN SHAPIRO MORIN & OSHINSKY LLP
2101 L STREET NW
WASHINGTON, DC 20037-1526

EXAMINER
KIELIN, ERIK J

ART UNIT	PAPER NUMBER
2813	21

DATE MAILED: 07/29/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 09/912,558	Applicant(s) WEIMER ET AL.	
	Examiner Erik Kielin	Art Unit 2813	

-- The MAILING DATE of this communication appears on the cover sheet with the correspond nce address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 May 2003* .

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *13,14,16,17 and 41-43* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *13,14,16,17 and 41-43* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

This action responds to the amendment filed 21 May 2003 (Paper no. 20).

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 13, 14, 16, 17, and 41-43 are rejected under 35 U.S.C. 112, first paragraph, because the specification, while being enabling for a pressure of 1 milliTorr for the wet oxidation, does not reasonably provide enablement for any pressure less than atmospheric pressure. The specification does not enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make or use the invention commensurate in scope with these claims.

The specification indicates states at page 9, lines 2-5,

> "The optimal pressure in the chamber will vary depending on the particular RTP system and wet oxidation technique used. In general, the pressure can be at about atmospheric pressure, although if the H_2 and O_2 gases are combined in the chamber 50, then the pressure should be kept lower, for example, around 1 millitorr."

Atmospheric pressure is 760 Torr. One milliTorr is $1/760000^{th}$ of atmospheric pressure. There is no support for varying the pressure anywhere between, below 760 Torr down to 0.001 Torr (i.e. 1 milliTorr).

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims **13**, 14, 17, **42**, and **43** are rejected under 35 U.S.C. 102(e) as being anticipated by US 6,114,258 (**Miner** et al.).

Regarding independent claims 13, 41, and 42, **Miner** discloses a method of forming a gate dielectric layer on a substrate comprising the steps of

depositing a dielectric film **105** over an active region of a semiconductor substrate **100** to from part of a gate of a transistor (col. 2, lines 20-22), wherein the dielectric film is, *inter alia*, silicon nitride (col. 4, lines 31-36; Figs. 1-3) --as further limited in claim 17; and

subjecting the dielectric film to a wet oxidation with steam provided by heating a mixture of hydrogen and oxygen gases in a rapid thermal process chamber at a temperature greater than 450 °C, particularly 400 °C to 1200 °C (col. 8, lines 13-32) and a specific example of 950 °C (col. 8, lines 44-56) --as further limited by instant claim 14-- and wherein said steam is provided in a ratio of at least 0.005 relative to other gases present in the rapid thermal process chamber, and the pressure is less than atmospheric pressure (col. 7, line 66 to col. 9, line 20).

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

6. Claims **13**, 14, 16, 17, **41**, **42**, and **43** are rejected under 35 U.S.C. 103(a) as being unpatentable over the article **Luan**, et al. "Ultra thin high quality Ta_2O_5 gate dielectric prepared by in-situ rapid thermal processing" Electron Devices Meeting, held 6-9 December 1998, IEDM '98 Technical Digest, pp. 609-612 in view of US 6,063,698 (**Tseng** et al.).

Regarding independent claims 13, 41, 42, and 43 **Luan** discloses a method of forming a gate dielectric layer on a substrate comprising the steps of

depositing a dielectric film over an active region of a semiconductor substrate to from part of a gate of a transistor, wherein the dielectric film is tantalum oxide (Ta_2O_5), as further limited in claim 17, having the inherent property of a dielectric constant of "at least about 25" (Introduction), as further limited in instant claim 16; and

subjecting the dielectric film to a wet oxidation with a steam process to "improve film quality and reduce leakage current" by heating a mixture of hydrogen and oxygen gases using rapid thermal processing (RTP) and therefore occurring, by definition, in a RTP chamber, at a temperature of 600 °C for a period of about 40-50 seconds (Fig. 1), and wherein the pressure of said rapid thermal process chamber is inherently less than atmospheric pressure. (See whole **Luan** article which is very brief.)

While Luan is silent as to the pressure --suggesting that the pressure is unimportant to the process-- it is, nonetheless, seen to be inherent that the pressure in the RTP chamber is less than atmospheric because of the stoichiometry of the reaction between hydrogen and oxygen to form water: $2H_2 + O_2 \rightarrow 2H_2O$. Because there is a net decrease in number of molecules (from 3 to 2), and because pressure is directly proportional to the number of molecules present by the ideal gas law PV=nRT, where P is the pressure, V is the volume, "n" reflects the number of molecules (in moles), R is the ideal gas constant, and T is the temperature, the pressure necessarily decreases upon the reaction of hydrogen with oxygen. Accordingly, the pressure is less than atmospheric, since the pressure decreases in the RTP chamber. Moreover, the specification points out that atmospheric pressure or 1 milliTorr are sufficient pressures, indicating that the pressure is not critical to achieving the objective of increasing the oxygen content of the dielectric layer and thereby reducing leakage current. (See MPEP 2112.)

It is also seen to be inherent that the oxygen content of the dielectric layer is increased because the film quality is improved and the leakage current reduced, as admitted in the instant specification to be known in the art and to be inherently provided by a wet oxidation process (instant specification, Abstract; p. 1, lines 28-32; p. 3, lines 13-20, p. 4, lines 9-13, etcetera.) Since Luan teaches the leakage current is reduced by performing a wet oxidation using hydrogen and oxygen, it is seen to be inherent based upon Applicant's admissions of record, that the oxygen content of the dielectric layer is increased. (See MPEP 2112.)

Luan does not teach a wet oxidation temperature in the range of 750-950 °C or a ratio of H_2 to O_2 of about 0.1 to 0.8 (i.e. 10% to 80% H_2), or is performed at a pressure less than atmospheric.

Tseng teaches a process virtually identical to **Luan** of forming a tantalum oxide gate dielectric **14** on a semiconductor substrate **12** and then wet oxidizing by heating a mixture of H_2 and O_2 to a temperatures of 750-850 °C, wherein the H_2 to O_2 ratio is about 0.03 to about 0.09 (col. 6, lines 58-63) to beneficially "eradicate trap sites **16** and **18**" (col. 6, lines 39-57). The **Tseng** teaches that the flow rate of O_2 is 20 liters per minute and that of the diluted H_2 is 10 liters per minute, wherein the amount of hydrogen in the mixture is 3% to 9%. (See also Abstract; col. 5, line 54 to col. 6, line 17.) Given that the reaction between H_2 and O_2 is as follows:

$$2H_2 + O_2 \rightarrow 2H_2O$$

Given this stoichiometry, when the hydrogen reacts with the oxygen to form steam in accordance with the teaching in **Tseng**, 9% of the oxygen present will react to form water. The net result is 0.09 times 30 liters per minute which is 2.7 liters per minute of water as steam. Also given the stoichiometry, the total volume decreases because 3 molecules are converted to 2 molecules. This means that there is a net loss of 1/3 times 2.7 liters per minute which is a loss of 0.9 liters per minute. So the total volumetric flow rate is 30 - 0.9 = 29.1 liters per minute. So the final reacted mixture yields steam at 2.7 liters per minute in 29.1 liters per minute of total gas mixture which is 2.7 divided by 29.1 liters per minute which is a ratio of steam 0.093 relative to the total gas mixture which is greater than 0.005.

It would have been obvious to one of ordinary skill at the time of the invention to modify the method of **Luan** to use the temperature and ratio of hydrogen to oxygen taught by **Tseng** in order to beneficially reduce the trap sites and improve the dielectric as taught by **Tseng** and to further reduce the leakage current as taught by **Luan** which is a direct measure of the reduction

of trap sites, as taught by **Tseng** (Abstract; col. 4, first paragraph)--especially since the methods are virtually the same.

Further in this regarding, it would be a matter of routine optimization to determine the optimum ratio of hydrogen to oxygen, since **Luan** clearly teaches the use of hydrogen and oxygen therefore expressly indicating some ratio. It has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. *In re Huang*, 40 USPQ2d 1685, 1688(Fed. Cir. 1996). In the instant case, Applicant has not provided any evidence that the claimed ratio provides unexpected results relative to that used in **Luan** in view of **Tseng** --especially since **Luan** only fails to indicate what the ratio of hydrogen to oxygen is, such that one of ordinary skill would be motivated to optimize the ratio to get the best results. Furthermore, the temperature would also amount to routine optimization with consideration to **Tseng** because, it has been held that claimed ranges of a result effective variable, which do not overlap the prior art ranges, are unpatentable unless they produce a new and unexpected result which is different in kind and not merely in degree from the results of the prior art. *In re Huang*, 40 USPQ2d 1685, 1688(Fed. Cir. 1996).

Regarding claim 41, if it is thought that **Luan** does not inherently teach an actual thickness of Ta_2O_5 of greater than 40 Å, then this may be a difference. But **Tseng** teaches that a T_{eq} (*equivalent* thickness relative to an actual thickness of SiO_2) of 20 Å is equal to an actual thickness T_{actual} of 60 Å of high dielectric constant material (e.g. tantalum oxide, Ta_2O_5). (See Tseng, col. 4, line 35-43). This indicates that the **Luan** T_{actual} is **necessarily** thicker than the T_{eq} reported because tantalum oxide is a high dielectric constant material. **Luan** teaches a T_{eq} of 13-

25 Å wherein the13 Å T_{eq} is the "thinnest ever reported." (See Luan, first paragraph under the section entitled, "2. Leakage Current")

Accordingly, it would be obvious for one of ordinary skill in the art, at the time of the invention, to form the tantalum oxide in **Luan** to T_{actual} 60 Å to attain the T_{eq} of about 20 Å reported in **Luan**, as taught also by **Tseng**.

Response to Arguments

7. Applicant's arguments filed 21 May 2003 (Paper No. 20) have been fully considered but they are not persuasive.

In the paragraph bridging pages 4 and 5 and the first full paragraph on page 5, Applicant argues that Miner does not teach increasing the oxygen content of the dielectric layer. Examiner respectfully disagrees. Figs. 9a, 10a-10c, 14, and 15 of Miner clearly shows the oxygen content of the dielectric layer to be increased and is present throughout the dielectric layer because the original dielectric layer Si_3N_4 has no oxygen in it, but does after the oxidation.

Applicant argues on pages 5 to 6 that Tseng has not taught the range of hydrogen gas to oxygen gas of 0.1 to 0.8. It is respectfully submitted, base upon the evidence of record, that Tseng is not required to. Tseng does however teach that the ratio may be 0.093 which is significantly close to 0.1. Applicant has not provided evidence that the range of hydrogen to oxygen is critical to the objective of the invention. Rather the specification states only that the claimed ratio is "suitable." (See instant specification, p. 8, lines 18-20.) Moreover, Tseng is provided only to show that the ratio for wet oxidizing Ta_2O_5 provides ratios of hydrogen to oxygen that are close to those instantly disclosed. More importantly, Luan does not teach any

ratio of hydrogen to oxygen, such that one of ordinary skill would necessarily have to optimize the process of Luan, even in the absence of the teaching in Tseng. So even in the absence of the teaching of Tseng, the teaching of Luan alone, along with the absence of any evidence of criticality of the ratio of hydrogen to oxygen is merely a matter of routine optimization, in the absence of some unexpected result, as noted in the rejection. See also *In re Woodruff*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). Because both the instant method and the method of Luan use wet oxidation and both recognize that the same objective is achieved --i.e. reduced leakage current-- there is simply no unexpected result.

In the last paragraph on p. 5, Applicant argues, on the one hand, that there is no motivation in Luan to deviate from the teachings of Tseng," and in the last paragraph on p. 6, argues in direct contradiction, that Luan should deviate from the teachings of Tseng stating, "Thus the asserted combination of Luan and Tseng, if proper, would completely contradict each other since Luan teaches an anneal temperature of 600 °C." It is respectfully submitted that it is clearly illogical to suggest that Luan not deviate from the teachings of Tseng and then assert that the combination is improper, suggesting that no modification of Luan by the teachings of Tseng should occur.

Further in regard to the last paragraph on page 6 and the first paragraph on page 7, Examiner respectfully disagrees that there is a teaching away between the references of Luan and Tseng with regard to the temperature. Note that the exemplary embodiment that Applicant singles out refers to annealing only after the formation of the gate, while the method of Luan forms the gate electrode *after* the anneal, so temperature is not an issue since no gate electrode

has yet been deposited. Something that is not yet been deposited cannot be damaged since it is not there. It is respectfully submitted that the combination of references is proper.

Conclusion

8. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication from examiner should be directed to Erik Kielin whose telephone number is (703) 306-5980 and e-mail address is erik.kielin@uspto.gov. The examiner can normally be reached by telephone on Monday through Thursday 9:00 AM until 7:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached at (703) 308-4940 or by e-mail at

carl.whitehead@uspto.gov. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9318 for regular communications and 703-872-9319 for After Final communications.

EK
July 14, 2003

CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800